

An Overview of Pilot Projects in Support of Critical Infrastructure Resilience

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Abstract — This paper describes two pilot projects undertaken in the Province of British Columbia (BC) by the Defence Research and Development Canada - Centre for Security Science (DRDC CSS) in partnership with Emergency Management British Columbia (EMBC) and local communities. The pilot projects occurred between May 2012 and September 2013 with three communities of population ranging from 5000 to 90,000. Various aspects of CI resilience were targeted, from understanding and analysing dependencies to enhancing planning. Different analytical approaches were employed and evaluated, including architecture frameworks, soft systems methodology and value-focused thinking. In a previous paper describing the problem formulation and solution strategy, a number of challenges to CI resilience were identified, related to governance, trust, information sharing, culture, assessment methodologies and resources. Pilot projects are discussed here in the context of these challenges. Our experience has led us to hypothesize that it is not tools per se that communities want, but rather meaningful analyses performed with an understanding of the local environment.

Keywords — *critical infrastructure, resilience, pilot project, tools, architecture frameworks, soft systems methodology, mission to task analysis, value-focused thinking, risk, emergency management, British Columbia*

I. INTRODUCTION

Following a partnership for enhancing safety and security for the Vancouver 2010 Olympics, the Defence Research and Development Canada – Centre for Security Science (DRDC CSS) and Emergency Management British Columbia (EMBC) developed a collaborative project focused on Critical Infrastructure (CI) and risk assessment. Goals for the project included demonstrating the value of a scientific, structured approach for improving emergency management (EM) capabilities, and developing approaches to the CI problem, including tools and assessment methodologies, that could be applied nationally (that is, in other municipalities and provinces).

The overarching project aligned with Public Safety Canada's National Strategy for Critical Infrastructure [1] and the (preceding and current) Action Plan for Critical Infrastructure [2], which focus on three areas: building partnerships, implementing an all-hazards risk management approach, and sharing and protecting information.

Our problem formulation of “the CI problem”, one which we characterized as a “wicked problem”, and solution strategy are discussed in detail in previous papers [3, 4]. In addressing the problem, we identified challenges under a number of themes [4], several of which will be discussed in the context of two pilot projects that have since been completed.

II. PILOT 1 – SYSTEMS ANALYSIS OF COMMUNITY RESILIENCE

The Systems Analysis of Community Resilience pilot project was carried out in the community of Pemberton Valley (PV), BC, located 30km northeast of Whistler, BC, with a population of approximately 5000. Within the community there are three distinct groups: the Village of Pemberton, rural residents from the Squamish Lillooet Regional District (SLRD), and the Lil'wat Nation Mount Currie Band. PV has no shortage of natural hazards, being vulnerable to flooding, wildfire and rockslides, and in the past decade has experienced a major flood [5] and one of the three largest rockslides in Canadian history [6].

Community resilience and CI resilience go hand in hand. The goal of this pilot project was to help the community understand the hazards they face, the resources they rely on, and steps that can be taken to mitigate/prevent, prepare for, respond to and recover from incidents. At the same time, we wanted to evaluate the utility of architecture frameworks (AF)¹ and soft systems methodology (SSM)² in examining the community as a “resiliency system” from an essential services

¹ A logical structure for classifying and organizing complex information

² A methodology designed to capture potentially divergent views on “the problem” from different stakeholders

(that is, CI) perspective. The work was carried out by primarily by Serco UK, who had developed the “Combined Effect methodology”³ [7] in the study of the St Pancras Railway Station in London, UK and later applied it in a study of the Ottawa International Airport in Ottawa, Canada.

For this project, the resiliency system was defined as the “set of plans, capabilities and resources strengthening a community’s ability to withstand disruptive influences and enabling it to recover from crisis events” [8]. As part of the study, “life support” systems (such as shelter, water, food, energy, communications), key capabilities supporting those systems (such as emergency services, the road network, etc.) and shared dependencies among the systems were identified. The community’s ability to manage incidents without the immediate assistance of provincial or national resources, through an earthquake scenario isolating the community for an extended period of time, was also tested.

The project began in the spring of 2012 with discussions involving DRDC, Serco, EMBC and the local emergency program coordinators (EPCs) to gather information (such as the community risk assessment, demographic information, etc.). Serco reviewed the documentation provided and conducted additional research to get as much background information as possible before we visited the community in June 2012. During this visit an extensive tour of the community was performed and discussions were held with EPCs from the three community groups and first responders. Based on these discussions, additional information that was provided and open source research, the provision of essential services in Canada’s ten CI sectors [1] plus shelter were examined.

Workshops in October 2012 were held with representatives from 28 organizations in four groups: the Lil’wat Nation group, the PV “community” group, the PV “business” group and the first responders group. Within each workshop, participants were asked a series of questions focused on: what PV is known for / what it provides; essential services; hazards to essential services; consequences of disruption over three days and three weeks; and expectations of service restoration after disruption.

Following the workshop, the analysis of the gathered information and the architectural development were performed. Validation sessions of the results were held in Pemberton in February 2013. In addition, with the first responders group, a scenario workshop was held to stress the community using a major earthquake centred near Vancouver and causing damage to infrastructure in the valley.

Outputs of the study included: a “Community Resilience Framework” template developed using architecture frameworks; a hazard-service matrix identifying impacts of hazards on community services; a service-service matrix identifying impacts between supplied services and dependent services and who in the community (responders, business, community) would be affected.; and a number of specific recommendations for the community to enhance preparedness

(such as creating generic plans for specific incident types and a pre-determined restoration priority guide) [8, 9].

The AF and SSM approaches were evaluated for DRDC CSS [10]. A number of advantages of the AF approach were identified, including the sophistication of the model and the ability to capture complexity; the ability to extract a reusable generic model from the specific model; and the ability to construct a consistent bank of architectures over time for use as a key resource. Disadvantages included the complexity and skills requirement; the workload to build and analyse the model; and the cost of the software tools. Advantages of SSM were that it allowed issues to surface, including the three community perspectives and divergent views on several issues; and it was a good fit with the AF approach. The main disadvantage for this project related to the limitations of the workshop analysis approach, such as, the small sample size possibly skewing results despite the wide range of respondents; and workshop dynamics, where some fidelity of individual views was lost through group responses, and group results were possibly skewed by dominant individuals.

In a previous paper [4], a number of challenges related to addressing “the CI problem” were identified under the themes of governance, information sharing, trust, culture, assessment methodologies and resources. In this pilot study we encountered aspects of all of these.

Since CI is a multi-stakeholder governance problem, it requires the public and private sectors to work together. In PV, we observed collaborative relationships and trust among public sector organizations - in particular, among the community EPCs from the village, SLRD and the Lil’wat Nation, and the first responder organizations. We also observed that there were leaders in the community, such as the Fire Chief, who strove to remove barriers among the communities and organizations, for example, by conducting joint training among the village and Mount Currie fire departments. However, collaboration with the private sector was generally not as forthcoming. This could be due, in part, to the fact that many of the systems (for example, hydro, telecommunications, rail) are operated by large companies with staff physically located in other parts of the province or country, therefore limiting the community’s ability to establish relationships. As we identified previously, trust and interpersonal relationships are often critical when it comes to CI information sharing.

Despite the existing collaborative relationships, tensions were identified resulting from legislation and policies. For example, the focus in EM is often on response versus mitigation or prevention, including with funding models. Therefore, while the community may want to take steps to mitigate or prevent the consequences of incidents (such as flooding), funding models may not support this. This in turn means that money is spent on response when incidents occur, and often provincial resources are required. Furthermore, the First Nations community is subject to different legislative and financial regimes than other communities in the valley, even though they face similar hazards and share a reliance on the British Columbia Emergency Response System. There are also cases where addressing a problem from one group’s perspective could exacerbate a problem from another’s. For

³ A systematic approach to developing a picture of security and resilience in complex systems

example, the dredging of river sandbars to provide flood relief would disrupt natural fish habitats.

Through the use of SSM, that is, seeking to understand the perspectives of the various communities, three distinct community views emerged. The First Nations community felt that their traditional skills and strong sense of community would enable sustainment to ride out disruptions longer term. Similarly, the rural community felt that they would have resilience for certain problems; this was more from a “frontier spirit” based on personal independence than a sense of community as with the Lil’Wat Nation, and a way of life including stores of preserved food, their own water supplies using wells, and wood stoves for heating and cooking, for example. The village community was generally the least self-sufficient group and the most dependent on external support for survival, for example, requiring food supplies in as little as a few days. Another interesting result that emerged from the workshops was an indication that the public likely has unrealistic expectations of service restoration for shelter, water, food and emergency services following a major incident.

Given the small size of PV there were people, such as the Fire Chief, who had extensive knowledge (the “big picture”) of the community in their heads based on years of experience and strong relationships (trust) within the community. However, documenting that knowledge provides others with access to the material, which may be crucial in the event that key individuals are indisposed at the time of incidents. Of the project outputs we presented to the community, we received very positive feedback on the simple matrices identifying hazards, dependencies and potential impacts. In fact, we are using the matrices in a new project as the basis for the development of a CI self-assessment tool for local governments in Canada.

The local resources required for this project were community representatives to attend meetings, ranging from one to several hours on two to three separate occasions, to provide subject matter expertise and individual perspectives. In particular, our heaviest reliance was on the EPCs who helped with scheduling, invited participants to meetings and workshops, provided information, etc. The analysis was performed by Serco UK.

III. PILOT 2 – SCENARIO-BASED MISSION TO TASK ANALYSIS USING VALUE-FOCUSED THINKING FOR HAZARD PLANNING

The Scenario-Based Mission to Task Analysis (MTA) using Value-Focused Thinking (VFT) pilot project was undertaken with two communities on Vancouver Island: the City of Nanaimo, a port city with a population of approximately 90,000, and the City of Parksville, a retirement / seaside resort community with a population of approximately 12,000. The two communities were chosen because of distinct properties, Nanaimo with a full time fire department and EPC, and Parksville with a volunteer fire department and part-time EPC, to determine if this would affect project outcomes.

The pilot project goals were twofold: to assist the development of communities with the development of community-wide risk treatment plans for specific hazards across the four pillars of EM, and to evaluate the utility of the approach (similar to the previous pilot). The overall approach

was to employ the “mission to task analysis” method used by the military. For a particular hazard scenario, this involves identifying: the overall “mission” or community goal (that is, the community values); the agreed-upon community objectives; and the associated tasks for individual organizations. The objectives and tasks resulting from the analysis provide the basis for a community-wide plan.

In order to structure community objectives, VFT was used to identify fundamental and means objectives and the connections between them. A typical approach to problems uses what Keeney [11] refers to as “alternative-focused thinking”, where one figures out the alternatives available and chooses the best among them. VFT is a different approach in that it requires one to first decide what is desired (what one values) and then figure out how to get it. It helps to provide “the big picture” and should provide options with more of what is desired. The community participants referred to this approach as “thinking backwards” because the question “why is this important?” was continually asked.

The project began the spring of 2012 with discussions with EMBC and the EPCs. Initial community visits were held in July 2012 that included community tours and discussions of hazards and challenges with stakeholders. Following the initial visit it was agreed to that the two scenarios per community would be hazardous material spill and earthquake for Nanaimo, and earthquake and interface fire for Parksville, the highest risks according to the community risk assessments.

Framework scenarios were developed for each community and stakeholder meetings were held in November 2012 to review scenarios for credibility and collect community objectives related to the scenarios. Following the meetings, objectives were reviewed, collated and analysed using VFT, in consultation with KaDSci, and initial models were developed for each scenario. In March and April 2013 the models were reviewed with the communities and exercises using each model were run by KaDSci in May and July 2013. Final project results were presented to the communities in September 2013.

Project outputs included visual models consisting of objectives and relationships between them, along with supporting tasks. Several research reports documenting the approach, including an overall assessment [12], were produced by KaDSci for DRDC CSS. Using mission to task analysis provided a structured approach to building a community-wide plan, while VFT allowed diverse stakeholders to identify common values and community objectives. The scenarios proved useful for providing the initial context for discussions, though there was less value in the precision of scenarios; rather, a portfolio of scenarios representing “all hazards” would be more useful. A challenge in applying the VFT approach is with the level of granularity; in this case there was likely too much detail. The models developed represented the participants and were a reflection of their expertise and, as a result, mitigation/prevention and recovery were sparse compared to preparedness and response.

The connection between the hazards/plans and CI should be obvious: hazards can disrupt CI and, therefore, EM plans should address the restoration of infrastructure and services for citizens and responders. In the earthquake scenarios considered

in each community, there were significant disruptions to CI, such as power and telecommunications outages, transportation disruptions (for example, impassable roads), damaged water and sewage systems, etc.

Participants in the pilots included representatives from emergency programs, first responder organizations, health authorities, city departments (for example, engineering), volunteers and private sector companies. A particular challenge in developing community-wide plans relates to the multi-stakeholder governance structure. Unlike within the military, for example, there is no one person “in command”, and in larger communities, few, if any, individuals may understand “the big picture” with all its components. VFT allows stakeholders to understand their roles in the context of contributing to larger community objectives, and how the roles of others contribute. Participants reported that there was a lot of value in the discussions (information sharing) throughout the process.

Local community resources included the EPCs to help coordinate and organize, as well as all participants’ attendance at a series of sometimes full day meetings. Many participants reported that the time commitment was too intensive. This was in part a reflection of the need to condense face-to-face work into a short time due to project travel budget restrictions. Additionally, several more steps in the project would have been useful to walk the community through the use of the results, as there was some uncertainty of how to proceed from the model itself.

IV. DISCUSSION AND CONCLUSIONS

With respect to the overarching project objective for improving EM capabilities, we believe we were able to demonstrate value through structured, systematic approaches, analysis and evidence-based results. That said, we certainly recognize that there is more work to be done.

We learned some valuable lessons with these pilot projects. We have maintained contact with the communities and both projects have a resulted in behaviour changes, which, in our view, makes them a “success”. However, the results of the Systems Analysis of Community Resilience project for PV were more concrete, more straight-forward, perhaps more “complete” and more eagerly embraced by the community. Based on the small sample size it is difficult to know how much of the success of a project is particular to a community and how much could be generalized to any community. For example, if we replicated the approach of the first pilot in a community other than PV, would it be as successful?

Resources will continue to be a challenge in these fiscally lean times. Any approach taken must be cognizant of the time requirements it imposes on participants. We recognized this at the onset though it was difficult for us to predict the level of engagement required, since we were developing tools and processes as the projects progressed.

Working through EPCs and current EM policies led to input and results that were often response-focused; in general, mitigation/prevention and recovery were weak (preparedness

less so as it relates to response). Additionally, although engaged to some degree, the private sector was not particularly strongly represented in either project, and not necessarily for lack of trying. Efforts to engage the private sector in community and CI resilience efforts must be continued.

We have observed time and again that, more than a tool, communities seem to want and need analysts who can use tools and/or structured approaches to provide insight and help with the interpretation and use of the results in the local environment. This, in fact, appears to be a capability gap at multiple levels of government. In both communities, we received feedback that having objective outsiders perform analysis with no vested interests lent credibility to the work. While we recognize the need to create self-sustaining tools since we can’t provide analysts to each and every community, it is difficult to create an “analyst in a box”, and attempting to do so requires careful thought and testing.

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